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<p>(21) International Application Number: PCT/US95/09152</p> <p>(22) International Filing Date: 12 June 1995 (12.06.95)</p> <p>(30) Priority Data: 08/259,712 14 June 1994 (14.06.94) US</p> <p>(71)(72) Applicant and Inventor: DESAI, Ashvin, H. [US/US]; 2195 Trade Zone Boulevard, San Jose, CA 95131 (US).</p> <p>(74) Agent: JAFFER, David, H.; Rosenblum, Parish & Isaacs, PC, 15th floor, 160 W. Santa Clara Street, San Jose, CA 95113 (US).</p>		<p>(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, TT, UA, UZ, VN. European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG).</p> <p>Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</p>	
<p>(54) Title: ENDOSCOPIC SURGICAL INSTRUMENT</p> <p>(57) Abstract</p> <p>An endoscopic surgical instrument (201) includes a housing (210), a single access conduit (212) formed in the housing (210), an irrigation port, and an evacuation port, each port being connected through independent valves to the single access conduit (212). The single access conduit (212) has a first end and a second end which is terminated in an aperture formed in the housing (210). A closure is provided for the aperture. A viewing device, such as an endoscope, is insertable through the aperture and the single access conduit (212), and is extended slightly beyond the first end. An electrode assembly (202) having two or more retractable RF electrodes spaced a predetermined distance and angle apart, is also insertable through the aperture and the single access conduit (212), and is extendable beyond the first end. Each RF electrode is in electrical communication with a means for supplying RF energy and for continuously measuring impedance across the electrodes.</p>			

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Specification
ENDOSCOPIC SURGICAL INSTRUMENT

RELATED CASES

This application is a continuation-in-part of my co-pending U.S. Patent Application serial No. 08/025,003, filed March 2, 1993 which is a continuation-in-part of my co-pending U.S. Patent Application Serial No. 07/779,108 filed October 18, 1991.

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a surgical instrument and more particularly to an instrument with the capability for continuous irrigation and evacuation of fluid into and out from a body cavity of a patient during Laparoscopic or Endoscopic surgical procedures, and for the simultaneous measurement of tissue impedance and the ablation of tissue with fixed or retractable electrodes using R.F. energy.

Brief Description of the Prior Art

Laparoscopic/endoscopic surgical procedure allows a surgeon to see inside the body cavity of a patient without the necessity of large incisions. This reduces the chances of infection and other complications related to large incisions. The endoscope further allows the surgeon to manipulate microsurgical instruments without impeding the surgeon's view of the area under consideration.

During these surgical procedures it is desirable for as few lines as possible to enter the body of the patient. This reduces the size of the incision the surgeon needs to make. It follows from this that the greater the number of functions provided by a single instrument or the greater the number of instruments able to be passed through a single line entering the patient's body, the better.

Furthermore, in certain procedures it may be desirable to irrigate the area under consideration. This in turn necessitates the evacuation of the irrigation fluid or.

1 when bleeding has occurred, the blood or smoke or tissue
2 residue generated by the surgical procedure.

3 From what has been said above it should be apparent that
4 it is preferable for both irrigation and evacuation to be
5 conducted along a single conduit which, also, acts as an
6 access line for surgical instruments.

7 A typical device which is used in endoscopic procedures
8 is an electrosurgical probe. Typically such a probe will
9 comprise a radio frequency (i.e. R.F.) energy conductive
10 tube covered with a dielectric material such as polyolefin
11 or Teflon. At one end, for convenience called the
12 operational end, each probe could have any one of a number
13 of functionally shaped monopolar or bipolar electrodes.
14 In addition a probe could have its end formed specifically
15 for irrigation and/or evacuation.

16 Monopolar and bipolar electrode probes are known in the
17 prior art. Monopolar electrode probes include a single
18 active electrode which is surgically introduced into a
19 body cavity and engageable with and insertable into a
20 tissue portion of the cavity. A passive electrode is
21 attached to the outer body surface of the patient, e.g.
22 typically a conducting plate is adhesively attached to the
23 patient's leg. The body of the patient serves to complete
24 the electrical circuit. Tissue ablation and coagulation
25 is achieved by introducing sufficient power into the
26 active electrode. Bipolar electrode probes include both
27 active and passive electrodes which are similarly
28 introduced together into the body cavity and are spaced
29 apart from each other by a predetermined distance. Each
30 electrode is engageable with and insertable into the
31 tissue portion. Thus, the electrical circuit is completed
32 by the body tissue disposed between the active and the
33 passive electrodes and only the body tissue disposed
34 between the two electrodes get coagulated.

35 Furthermore, any valves controlling the evacuation and
36 irrigation procedures should be constructed so as to
37 minimize the possibility of the valve malfunctions if, for
38 example, any tissue or blood coagulates around their

1 moving parts. Similarly if any of the instrumentation is
2 to be reusable, such instrumentation, including the
3 valves, should be capable of being efficiently cleaned by,
4 for example, flushing.

5 United States Patent 4,668,215 (Allgood) discloses a
6 valve for switching between an evacuation and an
7 irrigation conduit and allowing both such evacuation and
8 irrigation to be done via a single line entering the
9 patient. The mechanism for switching between the
10 irrigation, evacuation and closed configurations is by
11 means of a L-valve or T-valve. This patent, in another
12 embodiment thereof, further provides for a piston valve
13 for making an on-off connection between an evacuation port
14 and the line leading into the patient.

15 The L- and T-valves have the disadvantage that they must
16 be manipulated by rotation by the surgeon, usually using
17 his/her free hand. The piston valve disclosed in this
18 patent has the disadvantage that it has many areas where
19 blood and tissue accumulation and coagulation can occur
20 which may result in the malfunctioning of the valve. In
21 addition, the piston valve has numerous "dead" areas where
22 fluid flow would not occur. This precludes the device
23 from being effectively cleaned by commonly used flushing
24 techniques. Finally, the Allgood patent does not disclose
25 a single body for housing an evacuation/irrigation control
26 valve together with a housing for laparoscopic and
27 microsurgical instrumentation.

28 A surgical valve that the applicant is aware of is the
29 piston valve illustrated in Fig. 1 of the accompanying
30 drawings.

31 In this valve a piston 10 is located within a cylinder
32 11. The piston 10 can be moved along the bore of the
33 cylinder 11 by means of a plunger 12, from a closed
34 position (as shown) to an open position in which a conduit
35 13 is aligned with an access port 14. This allows fluid
36 flow along a path to or from access port 14, via conduit
37 13 and space 16 from or to a further port 15. Upon

1 release of the plunger 12 the piston 10 returns to its
2 closed position under action of a spring 17.

3 This valve, although easy to use, has the disadvantage
4 that blood and tissue accumulation occurs in space 16 and
5 clogs both the space and the spring 17. This may result
6 in undesirable over-evacuation or irrigation of the
7 patient during surgical procedures.
8

9 OBJECTS OF THE INVENTION

10 It is therefore an object of this invention to provide
11 a surgical instrument which includes control means to
12 allow for the continuous irrigation and evacuation of a
13 body cavity of a patient during microsurgical procedures,
14 with both irrigation and evacuation being performed along
15 a single line into the patient. The instrument should
16 also act as a mounting for electrosurgical probes and
17 microsurgical instruments.

18 A further object of the invention is to provide a
19 configuration for an instrument which, depending on the
20 material it is constructed of, can be both disposable and
21 non-disposable. In the event that the instrument is
22 "reusable" or "reposable" it is an object of the invention
23 to provide the instrument with conduits, access ports and
24 valves which can easily be cleaned by means of commonly
25 used cleaning techniques and conventional sterilization
26 methods.

27 It is another object of the invention to provide an
28 electrosurgical instrument with fixed or retractable RF
29 electrodes having the capability to simultaneously perform
30 controlled ablation of tissue using monopolar/bipolar R.F.
31 energy and precise measurement of tissue impedance.

32 SUMMARY OF THE INVENTION

33 According to this invention, an endoscopic surgical
34 instrument comprises an irrigation and an evacuation port,
35 each port being connected through independent valves to a
36 single access conduit; a probe connector located at one
37 end of the access conduit, the probe connector being for
38 receiving and retaining a hollow surgical probe; and a

1 monopolar or bipolar radio frequency connector which exits
2 into the access conduit in such a manner so as to make
3 radio frequency connection with a probe received by the
4 probe connector.

5 Preferably the connector for receiving an end, for
6 convenience called the locating end, of the probe would be
7 in the form of a receiving bore in the access conduit
8 which would include a plurality of O-rings which provide
9 a fluid-tight seal around the locating end of the probe.
10 These O-rings also function to retain the probe in the
11 receiving port while allowing the probe to be rotated. In
12 one embodiment of the invention, the O-rings are, instead
13 of being located within the receiving bore of the access
14 conduit, located about the locating end of the probe.

15 This invention also provides for a valve, for use as
16 either an evacuation or an irrigation valve, the valve
17 comprising a housing, an activator connected to the
18 housing, at least a first and a second valve access
19 conduit, both of which exit into the housing and a fluid
20 impervious seal mounted within the housing such that
21 activation of the activator causes the first valve conduit
22 to move axially relative to the seal and the second valve
23 conduit such that the seal is disengaged and the conduits
24 are placed in direct fluid communication with each other.

25 Typically, the instrument of the invention would contain
26 two of the above described valves. One valve would act as
27 an evacuator control while the other valve would act as an
28 irrigation control. Both valves communicate into a single
29 access conduit which, when the instrument is in use,
30 continuously flows into the patient via the receiving bore
31 and the hollow interior of the electrostatic probe.

32 Preferably the endoscopic surgical instrument of the
33 invention is in the form of a pistol with the "barrel"
34 portion thereof having, at one end thereof, the receiving
35 bore for the locating end of the endoscopic probe and, at
36 the other end thereof, the access port for the
37 microsurgical instruments and endoscopes.

1 The valves for controlling the evacuation and irrigation
2 procedures may be mounted in the "handle" portion of the
3 pistolshaped instrument. The valves may be mounted
4 alongside one another in the handle portion and may
5 protrude therefrom to allow finger control by the surgeon
6 using the instrument.

7 In one alternate embodiment of the invention the
8 surgical instrument includes a housing, a single access
9 conduit formed in the housing, an irrigation port and an
10 evacuation port, each port being connected through
11 independent valves to the single access conduit. The
12 single access conduit has a first end, and a second end
13 which is terminated in an aperture formed in the housing.
14 A closure is provided for the aperture. A viewing device,
15 such as an endoscope, is insertable through the aperture
16 and into the single access conduit. The viewing device is
17 of sufficient length such that it is extendable slightly
18 beyond the first end. A retractable electrode assembly is
19 also insertable through the aperture and into the single
20 access conduit, and is of sufficient length such that it,
21 too, is extendable beyond the first end. The retractable
22 electrode assembly, in one embodiment, includes two
23 retractable RF electrodes spaced apart by a predetermined
24 width. Each RF electrode is made from a superelastic
25 material, e.g. typically Nickel-Titanium (NiTi) metal, is
26 sheathed within a guiding sheath, and is slidable within
27 the sheath such that it is extendable beyond and
28 retractable completely within the sheath. Also, each
29 electrode is connected to a mechanism, operable by a
30 surgeon, for moving the electrode within the sheath. Each
31 electrode is extendable beyond its guiding sheath by a
32 variable length and at a predetermined angle from a
33 longitudinal axis of the single access conduit. Further,
34 each electrode is electrically communicative with means
35 for supplying R.F. energy and means for measuring
36 impedance continuously on a realtime basis.

37 These and other objects and advantages of the present
38 invention will no doubt become apparent to those skilled

1 in the art after having read the following detailed
2 description of the preferred embodiment which is
3 illustrated in the several figures of the drawing.

4 IN THE DRAWINGS

5 In the following drawings:

6 FIG. 1 is a partial sectional elevation through a prior
7 art piston valve;

8 FIG. 2 is a diagrammatic section through a semi-explored
9 elevation of one embodiment of the endoscopic surgical
10 instrument of the invention;

11 FIG. 3 is an illustration of a tricuspid valved access
12 port illustrated in plan (a) and elevation (b) views;

13 FIG. 4 is a section through a receiving bore of the
14 instrument illustrating one way of locating a probe in the
15 bore;

16 FIG. 5 is a section through a similar receiving bore
17 showing a different way of locating a probe in the bore;

18 FIG. 6 is a side view illustrating in (a)-(i) various
19 electrostatic probe operational ends;

20 FIG. 7 is a section through a valve according to the
21 invention with the valve being in the shut position;

22 FIG. 8 is the valve of FIG. 7 in the open position;

23 FIG. 9 is a partial section through a different type of
24 valve also suitable for use in the instrument of the
25 invention;

26 FIGS. 10, 11, 12 and 13 are diagrammatic illustrations
27 showing various configurations of valve operating buttons
28 and triggers;

29 FIG. 14 is an exploded view of an alternative embodiment
30 of the surgical instrument of the invention illustrating
31 a disposable valve cartridge;

32 FIG. 15 is a cross section through the disposable valve
33 cartridge illustrated in Fig. 14;

34 FIG. 16 is a partially sectioned view of another type of
35 valve which can be used in the surgical instrument of the
36 invention;

37 FIG. 17 is a perspective view of an alternate embodiment
38 of the endoscopic surgical instrument having generally

1 similar valves, as illustrated in FIG. 7-8, and a
2 retractable electrode assembly having bipolar RF
3 electrodes in electrical communication with a R.F. energy
4 source and a tissue impedance monitoring device;

5 FIG. 18 is a partial sectional view taken along the line
6 18-18 of FIG. 17;

7 FIG. 19 is a view taken along the line 19-19 of FIG. 17;

8 FIG. 20 is a side elevation view of the retractable
9 electrode assembly shown in FIG. 17;

10 FIG. 21 is an enlarged view of the tip of the
11 retractable electrode assembly shown in FIG. 17;

12 FIG. 22A-22H illustrate alternate electrode
13 configurations for the retractable electrode assembly
14 shown in FIG. 17 and 20;

15 FIG. 23 is an enlarged view of the tip of the
16 retractable electrode shown in FIG. 22D-22F; and

17 FIG. 24 is an alternate embodiment of the present
18 invention including a retractable electrode assembly
19 having a variable angle control mechanism.

20

21 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

22 In FIG. 2 of the accompanying drawings, the endoscopic
23 surgical instrument of the invention is generally
24 indicated as 20. The instrument 20 is shown to include an
25 irrigation port 21 and an evacuation port 22. Each
26 port, 21 and 22, is connected through independent valves
27 23 and 24, respectively, to a single access conduit 25.
28 The connection between the valves 23 and 24 and conduit 25
29 is along connector tubes 23a and 24a.

30 The access conduit 25 leads from the valves and their
31 respective valve conduits to a probe connector 26. This
32 probe connector 26 is designed to receive one end, the
33 locating end 27, of a surgical probe 28 which would be
34 used during microsurgical procedures. The connection 26
35 is described in more detail with reference to FIGS. 4 and
36 5 hereafter.

37 At or near the probe connector 26, a monopolar/bipolar
38 radio frequency connector 29 is located. As illustrated,

1 this is in the form of a R.F. connector. The advantage of
2 a R.F. connector is that it is an industry standard and
3 can be used for connecting the instrument 20 to standard
4 R.F. energy sources marketed by a number of different
5 manufacturers.

6 The radio frequency connector 29 exits into the access
7 conduit 25 where it makes connection with a point 30, on
8 the locating end 27 of a probe 28 received by the probe
9 connector 26.

10 The surgical instrument 20 also includes a port 31 which
11 allows the surgeon to insert microsurgical instrumentation
12 and viewing devices along the access conduit 25 and the
13 bore of the hollow probe 28 to exit from the end 32
14 thereof. The port 31 should provide a fluid-tight seal
15 when no microsurgical instrumentation is being used with
16 the surgical instrument 20. This will prevent fluid,
17 which may be moving along the access conduit 25 to or from
18 the patient, from leaking.

19 Typically, the access port 31 is in the form of a
20 commercially available tricuspid valve as illustrated in
21 FIGS. 3(a) and (b). In these figures, the valve 31 is
22 shown as being constituted by three segments 32 which in
23 plan view are wedge-shaped and which together form the
24 disc shaped sealing portion of the valve. The segments 32
25 are held together by means of a circumferential ring 33
26 which biases the three segments 32 together to form a
27 fluid-tight seal. In use, the microsurgical
28 instrumentation are inserted through the valve at a point
29 34 where the apexes of the segments 32 come together.
30 This insertion forces the elements of the valve apart to
31 allow ingress of the microsurgical instrumentation. The
32 effect thereof is shown in broken lines in FIG. 3(b).
33 When the instrumentation is removed from the valve 31, the
34 segments 32 are pulled together to form the seal.

35 In FIG. 4 the probe connector 26 is shown to be
36 constituted by a receiving bore which is coaxial with the
37 fluid access conduit 25. In practice, the diameter of
38 this bore would be the same as that of the access conduit

1 25 and would be sized to receive the locating end 27 of
2 the probe 28 in a relatively close fit. Within the bore
3 forming the probe connector, a plurality, typically two,
4 O-rings 36 are located. When the locating end 27 is
5 inserted into the bore 26 these O-rings provide a snug,
6 fluid-tight seal about the end 27. Once the locating end
7 27 of the probe is received within the bore 26 it is
8 capable of being rotated about its longitudinal axis, by
9 means of a knurled rotation knob 37 located between the
10 locating end 27 and the operational end 32 of the probe
11 28.

12 The probe 28 would typically be made of a electrostatic
13 conductive material coated with a non-conductive material
14 such as heat shrink polyolefin or Teflon.
15 Electrostatic/radio frequency energy is passed along the
16 probe 28 from the radio frequency connector 29 via
17 electrostatically conductive plates 38 located within the
18 bore of the probe connector 26 and onto the end 30 of the
19 probe 28. The end 30 is so designed such that when the
20 locating end 27 of the probe is received by the probe
21 connector 26, electrostatic connection is made between the
22 plate 38 and the connector 30. This allows the surgeon to
23 pass energy into the patient being operated on.

24 An alternative radio frequency connector is illustrated
25 in FIG. 5. In this case, the R.F. connector 29 exits into
26 the bore 26 in the form of a pin 39. In the conductive
27 end 30 of the probe 28 an L-shaped slot 40 is formed. As
28 the probe 28 is inserted into the receiving bore 26, the
29 pin 39 engages the axially-orientated leg 41 of the L-
30 shaped slot 40. When the probe can be inserted no further
31 along the bore it is twisted, in this case in an anti-
32 clockwise direction, such that the pin 39 and the axially
33 transverse leg 42 of the L-shaped slot 40 engage each
34 other to lock the probe 28 into position. In this
35 embodiment the probe 28 cannot be rotated by means of the
36 knurled knob 37.

1 FIG. 5 further illustrates an alternative positioning of
2 the O-rings 36. In this case they are located on the
3 locating end 27 of the probe 28.

4 From FIGS. 4 and 5, although not shown, it will be
5 apparent that the diameter of the operational shank 28a of
6 the probe 28 can be variable. Typically, the probe, as
7 shown, would have a diameter of 5mm. This diameter can,
8 however, be increased to 10mm which would be close to the
9 diameter of the locating end 27 of the probe, as well as
10 that of the internal bore diameter of the access conduit
11 25. The advantage of 10mm diameter probes is that the
12 evacuation of removed tissue and objects such as the gall-
13 stones can be more effectively achieved. Obviously, when
14 the bore of the operating shank 28a of the probe, the
15 locating end 27 and the access conduit 25 are all 10mm in
16 diameter, the diameter of the evacuation port 22 and its
17 related valve 24 and connector tube 24a must also be 10mm.

18 In FIG. 6(a) to (i), a side view of number of different
19 electrode shapes are illustrated. It will be appreciated
20 that the electrode tips could be either monopolar or
21 bipolar. In the case of bipolar electrodes, only one
22 electrode is illustrated since a second electrode is fully
23 obscured by the visible electrode. These electrode tips
24 would be located on the operating end of the probe 28.

25 As can be seen from the figure, a number of the tips are
26 not symmetrical about the longitudinal axis of the probe
27 28. It is for this reason that it is desirable for the
28 probe 28 to be mounted on the instrument in such a manner
29 to allow for a rotation of the probe about its
30 longitudinal axis. As has been previously indicated, this
31 will give the surgeon the opportunity of rotating any non-
32 symmetrical tips, inside the patient, without having to
33 rotate his or her wrist.

34 This invention extends also to an electrostatic probe
35 28, substantially as described in any of the FIGS. 4 to 6.

36 The details of one type of irrigation/evacuation valve
37 are illustrated in FIGS. 7 and 8. The valve 24 indicated
38 in both figures comprises a housing constituted by a

1 hollow tube 50 and an activator in the form of a button 51
2 formed integrally with the tube 50. A fluid impervious
3 seal 52 is located within the tube 50. Referring
4 specifically to FIG. 7, in which the valve is shown in the
5 shut position, it can be seen that the seal 52 lies
6 between a first valve conduit 53 which leads to the
7 evacuation port 22 (not shown) and a second valve conduit
8 in the form of connector tube 24a which leads into the
9 primary access conduit 25 of the surgical instrument. In
10 effect, the seal 52 prevents the conduits 53 and 24a from
11 being in communication with each other.

12 The first valve conduit 53 is mounted onto the wall of
13 the tube 50 and opens into the interior of the tube 50
14 through a hole 54. Between the seal 52 and the button
15 portion 51 of a tube 50, a spring 55 is located. On the
16 side of the seal 52, opposite to which the spring is
17 located, a tubular insert 56 is located. This tubular
18 insert has a snug but slideable fit over the outer wall of
19 the second valve conduit 24a as well as a tight, fluid
20 impervious fit into the inner bore of the tube 50. This
21 tube 56 acts as a stop which prevents the spring 55 from
22 pushing the seal 52 out of the hollow tube 50.

23 To open the valve, as is illustrated in FIG. 8, an
24 activating force, applied along a line F to the button 51,
25 will cause the button to move from the position indicated
26 in broken lines to the illustrated open-valve position.
27 As the button moves, so does the hollow tube 50, taking
28 the first valve conduit 53 along with it. In addition,
29 the leading edge 57 of the second valve conduit 24a bears
30 against the seal 52 causing the seal to move relatively to
31 the tube 50. This in turn disengages the seal from
32 sealing the hole 54 in the wall of the tube 50. The
33 movement of the first valve conduit 53, relative to the
34 second valve conduit 24a, places the respective openings
35 54 and 58 of these two conduits in fluid communication
36 with each other thereby allowing an unobstructed fluid
37 flow along both access conduits.

1 Upon release of the force on the button 51, the bias of
2 the spring 55 will return the valve to its shut position.

3 It is evident from the construction of the valves
4 illustrated in FIGS. 7 and 8 that they can be readily
5 cleaned by commonly used cleaning such as flushing. In
6 addition, the valves have almost no areas where blood and
7 tissue accumulation and coagulation can occur, and if such
8 accumulation and coagulation does occur the valves cannot
9 be jammed in the open position. This is because the
10 spring biasing the valve into its closed position is
11 located in an effectively sealed area. Furthermore these
12 valves have been tested to a pressure of up to 100 psi
13 without the integrity of the valve seal being adversely
14 affected.

15 An alternative form of valve, to that illustrated in
16 FIGS. 7 and 8 above, is shown in FIG. 9. In the figure
17 the valve is shown to include a generally cylindrical
18 valve body 60, an activating button 61 and a plunger 62.
19 A hollow bore runs down the center of the valve body 60
20 and contains the valve seal 63. The valve seal 63 is made
21 up of a circular washer 63a and a sealing O-ring 63b and
22 is screwed onto the bottom of plunger 62. The valve seal
23 63 is biased into its illustrated sealing position by
24 means of a spring 64 located in the bottom part of the
25 valve body 60.

26 To open the valve, the button 61 is depressed so that
27 the plunger 62 forces the valve seal 63 downwards against
28 the bias of the spring 64 to a position shown in broken
29 lines 63', in the figure. As a result, a fluid path,
30 indicated by arrows 65, is opened between an upper pair of
31 cutouts 66 and a lower pair of cutouts 67. Each pair of
32 cutouts opens into the hollow bore in the center of the
33 valve body 60 and, when this valve is inserted into the
34 surgical instrument, into either an evacuation or
35 irrigation conduit. Closure of the valve is achieved by
36 releasing the button and allowing the spring 64 to return
37 the valve seal 63 to the sealing position.

1 One advantage of this embodiment of the valve is that it
2 is easily removed from and inserted into the surgical
3 instrument of the invention. Accordingly the valve can
4 easily be removed for cleaning or disposal and
5 replacement. This is further illustrated below with
6 respect to FIG. 13. It is sufficient here to mention only
7 that the surgical instrument is provided with a receiving
8 bore for each valve and that the valve includes a
9 plurality (in this case 3) O-rings 68 which, when the
10 valve is inserted into its respective receiving bore,
11 provide a number of fluid tight seals against the inside
12 of the bore.

13 Either of the two types of valve described in FIGS. 7 to
14 9 can be used on the instrument 10. Typically one valve
15 would act as an evacuation valve while the other as an
16 irrigation valve. Different types of arrangements of
17 valves and valve activation means are illustrated in the
18 following 4 figures.

19 One way of activating the valve is by means of a rocker-
20 shaped trigger 70 illustrated in FIG. 10. The trigger 70
21 is pivotally mounted on a point 72 on the handle 74 of the
22 pistol. Depressing the trigger 70 to operate the
23 irrigation valve 71 would not interfere with the operation
24 of the evacuation valve 73. Similarly, operation of the
25 trigger 70 to operate the evacuation valve 73 would in no
26 way effect the operation of the irrigation valve.

27 In FIG. 11 a trigger mechanism 76 is shown for operation
28 of only one of the buttons. The other button 78 would be
29 located for operation by means of the surgeon's thumb in
30 a position removed from the trigger 76. This could, for
31 example, be near the top end of the handle portion of the
32 instrument.

33 Yet a further positioning of the buttons 71 and 73 is
34 indicated in FIG. 12. In this instance, the buttons
35 protrude from the top rear of the pistol handle and are
36 located side-by-side. To prevent confusion between
37 evacuation and irrigation procedures, the tops of the
38 buttons have different shapes. So, for example, the

1 button to manipulate the evacuation valve could be concave
2 while the button for manipulating the irrigation valve
3 could be convexly shaped.

4 FIG. 13 illustrates still another arrangement of buttons
5 and valves, in this case an arrangement particularly
6 suited to the valve shown in FIG. 9.

7 In this figure only the pistol grip 90 of the surgical
8 instrument of the invention is shown. An irrigation port
9 92 and evacuation port 94 enter the pistol grip 90 at the
10 bottom of its handle portion. The ports 92, 94 are, in
11 use, respectively connected to irrigation and evacuation
12 conduits (not shown) and, to this end, suitable
13 connectors, as illustrated, are provided.

14 The irrigation port 93 communicates with the main access
15 conduit 96 (referenced as 25 in FIGS. 2, 4 and 5) along an
16 irrigation conduit 98 which extends from the irrigation
17 port 93 and into the rear of the bore 100 which houses an
18 irrigation valve 102. From there it extends along the
19 bore 100 to a point near the front of the bore from where
20 it exits into the body of the grip 900 to enter rear of
21 the bore 104 which houses an evacuation valve 106. The
22 irrigation conduit extends directly across the bore 104 at
23 this point and becomes a central conduit 108 which
24 communicates with the access conduit.

25 On the other hand, the evacuation port 94 communicates
26 with an evacuation conduit 105 which extends along the
27 pistol grip 90 directly into the front of the bore 104,
28 down to the bore 104 to its rear from where it exits into
29 the central conduit 108.

30 In the position shown, both the irrigation and
31 evacuation valves 102, 106 respectively, are shown in the
32 off or shut configurations and neither evacuation or
33 irrigation can take place. Should irrigation of the
34 patient be required, the dish-shaped irrigation button 110
35 is depressed and the valve 102 opens (ie. its valve seat
36 moves to the right in the drawing) to allow irrigation
37 fluid to pass along the irrigation conduit 98 and into the
38 bore 104. In this bore 104 the evacuation valve 106 is in

1 the off configuration. However, a fluid path exists
2 across the pair of cutouts (67 in FIG. 9) and therefore
3 the irrigation fluid can pass through the body of the
4 valve 106 and into the central conduit 108 and, from
5 there, into the access conduit 96.

6 When evacuation is desired the irrigation button 110 is
7 released and the spring associated with the irrigation
8 valve 102 biases it into the shut or off configuration.
9 Thereafter the flat topped evacuation button 112 is
10 depressed to open the evacuation valve 106. This allows
11 the patient to be evacuated along the main access conduit
12 96, into the central conduit 108, then from the rear to
13 the front of the bore 104 and, from there, out along the
14 evacuation conduit 105.

15 As has been indicated earlier, the valves 102, 106 are
16 easily inserted into and removed from their respective
17 bores 100, 104. This allows the pistol grip 90 (which is
18 typically stainless steel and is reusable) to be cleaned
19 efficiently. The valves, typically being of plastic and
20 being difficult to clean, can be discarded and replaced
21 with new valves.

22 A variation on this theme of discardable valves is
23 illustrated in FIG. 14. In this figure the surgical
24 instrument is shown to include a pistol grip 120, a
25 surgical probe 122, which can be screwed into the front of
26 the pistol grip 120 and a radio frequency connector 124
27 which screws into the back of the grip 120.

28 The instrument also includes a removable (and
29 disposable) valve cartridge 126. The cartridge 126
30 includes an irrigation pipe 128 and an evacuation pipe 130
31 both of which are individually operated by valves (as will
32 be further illustrated in FIG. 15) under action of button-
33 shaped actuators 132. Both the irrigation and evacuation
34 pipes communicate into a single conduit (not shown) which
35 runs down the center of a male connector fitting 134.
36 Where the cartridge 126 is inserted into the grip 120 the
37 connector 134 fits into the base of a central conduit 136
38 which, in turn, opens up into the main access conduit 138

1 of the instrument. When the cartridge 120 is located in
2 the grip 120 the actuators 132 are located directly below
3 a pair of operating triggers 140 which can be used to
4 operate the irrigation/evacuation procedures described
5 before.

6 Finally, when the cartridge 120 is in place, it is held
7 there by means of a retainer clip 142 which clips in
8 behind the cartridge 120. The retainer clip 142 has
9 apertures 144 formed in it to allow the irrigation and
10 evacuation pipes 128, 130 to pass through it.

11 Although it will be apparent that the valve types
12 described above are also suitable for use in the cartridge
13 120, a further valve configuration is illustrated in FIG.
14 15, which illustrates the cartridge 120 in greater detail.

15 In this figure, the cartridge 120 is shown to include an
16 irrigation conduit 150 and an evacuation conduit 152, both
17 of which lead to a central access conduit 154 which
18 extends down the center of the male connector 134.
19 Irrigation and evacuation procedures are controlled by
20 irrigation and evacuation valves 156 and 158,
21 respectively.

22 The irrigation valve 156 consists of a valve seal 160
23 mounted onto a stem which is screwed into an activator
24 button 132a. A fluid tight seal is provided for the valve
25 156 by an O-ring 168 mounted onto the cap 132a. The valve
26 seal 160 seals against a valve seat, formed at the
27 junction between the irrigation conduit 150 and the
28 central access conduit 154 and is held in the sealing
29 position (as shown) by a spring 162.

30 Access to the valve seat is through a hole 164 formed
31 into the top (as shown in the drawing) of the cartridge
32 120. This hole 164 can be closed off with a cap 166 and
33 allows the irrigation valve 156 to be inserted into the
34 cartridge 120. This is done by inserting the valve seal
35 160 and its associated stem into the hole 164 from above
36 and inserting the spring 162 from below. Thereafter the
37 cap 132a can be screwed onto the stem to hold the entire
38 valve 156 in place.

1 To operate an irrigation procedure the button 132a is
2 depressed to move the valve seal 160 clear of its seal to
3 open a fluid path between the irrigation conduit and the
4 central access conduit. Releasing the button 132a causes
5 the spring 162 to force the seal 160 back into its seat
6 thereby automatically shutting the valve.

7 The evacuation valve 158 is of a different construction.
8 In this valve 158, the valve seal 170, in its off position
9 as shown, seals the mouth of the evacuation conduit 152.

10 In operation, the seal 170 is moved under action of a
11 plunger and evacuation button 132b from the position shown
12 to a position 170' in which an end of a conduit 174,
13 formed through the seal 170, aligns with the central
14 access conduit 154. At the same time the other end of the
15 conduit 174 is aligned with the evacuation conduit 152 and
16 evacuation can be accomplished. By releasing the button
17 132b, the spring 172 biases the seal 170 back into its
18 sealing position.

19 Assembly of this evacuation valve 158 is by inserting
20 the entire valve mechanism into its valve bore and sealing
21 a collar 176 in the bore.

22 As has been indicated with reference to FIG. 14, the
23 cartridge 120 is of the disposable type and is intended
24 for use only once. Accordingly the considerations of
25 valve flushing (during cleaning) are not entirely
26 applicable here.

27 In FIG. 16 yet another type of valve, which can be used
28 as either an irrigation or an evacuation valve, is
29 illustrated.

30 The valve, generally indicated as 180, is shown to
31 include a hollow cylindrical valve body 182 which is
32 sealed at its lower end by a valve seal 184 and at the
33 other by an activator button 186. The activator button
34 186 seals against the valve body with an O-ring 188 and is
35 connected to the valve seal 184 by means of a plunger 190.

36 To open the valve 180, the button 186 is depressed
37 against the bias of a spring 192 to move the valve seal
38 184 to the position indicated in broken lines. This opens

1 a fluid path 194 between an opening 196 formed in the
2 sidewall of the valve body and its lower end. Releasing
3 the button 186 allows the spring 192 to force the seal 184
4 back into the closed position.

5 One advantage of this valve is that it is very simple
6 and inexpensive to manufacture and can, therefore, readily
7 be disposed of.

8 Finally, it will be apparent to anyone skilled in the
9 art, that the surgical instrument of this invention could
10 be made from any suitable material. In the event that the
11 instrument is intended for single use, plastic material
12 could be used. Alternatively, for reusable or reposable
13 instrument, the instrument can be made of a more durable
14 material.

15 FIG. 17 is a perspective view of an endoscopic surgical
16 instrument 200 which is an alternate embodiment of the
17 surgical instrument 20 described above. FIG. 18 is a
18 partial sectional view of a portion of the instrument 200
19 taken along the line 18-18 of FIG. 17 and FIG. 19 is
20 another view of the instrument 200 taken as indicated by
21 the line 19-19 of FIG. 17. FIG. 20 illustrates the
22 retractable electrode assembly 202. When viewed together,
23 FIG. 17-20, illustrate the instrument 200 including an
24 endoscopic instrument 201, a retractable RF electrode
25 assembly 202, an continuous irrigation and evacuation
26 assembly 203, a R.F. energy source 285, and a tissue
27 impedance monitoring device 284. It will be appreciated
28 that, although two retractable RF electrodes are
29 illustrated and subsequently described, in alternate
30 embodiments the retractable electrode assembly could have
31 one or more than two retractable RF electrodes. Also,
32 although a bipolar retractable RF electrode assembly is
33 illustrated and subsequently described, it will be
34 appreciated that a monopolar retractable RF electrode
35 assembly could be used.

36 The assembly 203 includes a housing 210, an irrigation
37 valve assembly 214, and an evacuation valve assembly 220.
38 The housing 210 includes an elongated portion 228 having

1 a generally oval cross section. The portion 228 includes
2 a free tip end 230 and a secured end which is attached to
3 a handle portion 232. The portion 232 is held by the
4 surgeon, and the portion 228 is surgically introduced into
5 a body cavity (not shown) of the patient. A single access
6 conduit 212 (a portion of which is best seen in FIG. 18
7 and 19) is formed between an inner surface of the portion
8 228 and the objects carried within the portion 228. The
9 conduit 212 is disposed along the entire longitudinal
10 length of the portion 228 and is functionally similar to
11 the conduit 25 (FIG. 2) in that it permits the irrigation
12 and evacuation of fluids into and out from the body cavity
13 into which the portion 228 is inserted. The conduit 212
14 is open at the tip end 230 and can be accessed, at its
15 opposite end, via an aperture and associated closure 226
16 formed in the handle portion 232. The closure 226 is in
17 the form of a tricuspid valve and is substantially similar
18 to the valve 31 illustrated and described above (FIG. 2).

19 The irrigation valve and the evacuation valve assemblies
20 214, 220 are substantially similar to the irrigation and
21 evacuation valves 23, 24 described above (FIG. 2). The
22 valve assemblies 214, 220 operate in a similar manner to
23 valves 23, 24 (FIG. 7, 8). Depressing the valve
24 assemblies 214 or 220 permits the communication of fluid
25 in a valve first conduit 216 (or 222) with a valve second
26 conduit 218 (or 224). Each of the valve second conduits
27 218 and 224 are in fluid communication with the conduit
28 212 (in the same manner that the conduits 23a, 24a are in
29 fluid communication with the conduit 25, FIG. 2). Thus,
30 when the valve assembly 214 is operated, irrigation fluid
31 can be communicated to the conduit 212 and out through the
32 tip end 230, and delivered to the body cavity. In a
33 similar manner, fluids in the body cavity can be evacuated
34 if the valve assembly 220 is operated.

35 The retractable electrode assembly 202 includes a means
36 for guiding the angular orientation of the electrode or
37 guide sheath 248, an endoscope sheath 238, a electrode
38 movement mechanism 236, a tissue impedance measurement

1 device 284, and a R.F. energy source 285. The sheath 248
2 is generally parallel to the scope sheath 238. The sheath
3 248 and the sheath 238 are each insertable into an opening
4 of an insert flange 242, into the aperture of the handle
5 portion 232 of the assembly 203. The sheath 248 and the
6 sheath 238 are insertable within the conduit 212 and are
7 each of sufficient length such that when each is fully
8 inserted within the conduit 212, each extends slightly
9 beyond the tip end 230 of the cylindrical portion 228.

10 The endoscopic instrument or endoscope 201 is
11 substantially similar to the endoscope instrument
12 described above, and can be any of a number of devices
13 known in the prior art. An eyepiece 204 is shown attached
14 to the endoscope 201. The endoscope 201 is slid into the
15 scope sheath 238 until the eyepiece 204 engages a flange
16 240 which is attached to the sheath 238. Thus, the
17 endoscope 201, and the sheath 248 of the retractable
18 electrode assembly 202 are both insertable within the
19 portion 228 of the irrigation and evacuation assembly 203.

20 Each of two RF electrodes 250a, 250b is sheathed within
21 its respective guide sheath 248a, 248b. Although the
22 illustrated embodiment depicts two RF electrodes, it will
23 be appreciated that the assembly 202 could have one or
24 more than two electrodes. Each electrode 250a, 250b
25 includes a first or distal end 249a, 249b, a second, or
26 proximal end 247a, 247b, and a central portion (not shown)
27 disposedly connected therebetween. A coating of
28 insulation 246 is disposed onto the bare electrode 250.
29 The insulation coating 246 may be in the form of a tube of
30 material (such as teflon) heat shrunk around the bare
31 electrode 250. Alternately, the insulating coat 246 may
32 be powder deposited, using vacuum deposition techniques,
33 onto the bare electrode 250. In either case, nearly the
34 entire length of the bare electrode 250 is covered by the
35 insulating coat 246.

36 The electrodes 250a, 250b have a generally constant
37 diameter throughout its entire length and are sized such
38 that they can be slid within the sheaths 248a, 248b. That

1 is, there exists a sufficient clearance (e.g. 0.005 inch)
2 between the outside diameter of each of the insulating
3 coats 246a, 246b of the electrodes 250a, 250b and the
4 inner diameter of the respective sheaths 248a, 248b. Each
5 electrode 250a, 250b is made from a superelastic metal
6 material, e.g. typically a Nickel-Titanium (NiTi) metal
7 alloy. The guide sheaths 248a, 248b are made from a rigid
8 plastic or coated metal tubing which forms a rigid conduit
9 that guides, i.e. deforms, the electrode along a
10 predetermined path.

11 As best seen in FIG. 19, the electrodes 250a, 250b and
12 their respective sheaths 248a, 248b are contained within
13 the cross sectional envelope of the portion 228. Thus,
14 the required incision into the patient need only
15 accommodate the cross sectional area of the portion 228.
16 The presence of the extendable electrodes does not
17 increase the size of the required incision. It should be
18 also noted that each electrode 250a, 250b descends
19 downwardly into the field of view of the endoscope 201.
20 In this manner the surgeon is able to view the extension
21 of each electrode 250a, 250b beyond the end of the sheath
22 248a, 248b.

23 The two electrodes 250a, 250b and their respective
24 insulators 246a, 246b are encased within their respective
25 guide sheaths 248a, 248b which are encased within a
26 plastic insulating covering 244. The electrodes 250a and
27 250b encased within the plastic covering 244 exits the
28 housing 232 through the opening in the flange 242.

29 Each electrode 250a, 250b is in parallel electrical
30 communication with a tissue impedance measuring device 284
31 and a R.F. energy source 285. The covering 244 enters the
32 movement mechanism 236 through an opening 260 formed in a
33 sleeve 256 of the mechanism 236. The electrodes 250a,
34 250b and their respective insulators 246a, 246b exit from
35 the covering 244 and each of the second ends 247a, 247b,
36 of each of the electrodes 250a, 250b are attached to
37 connecting pins 272a, 272b, respectively. The connecting
38 pins 272a, 272b are mounted at an end of a plunger 264.

1 Each connecting pin 272a, 272b is in communication with a
2 wire 274a, 274b each of which passes through the plunger
3 264, through an opening 278, and into an insulated line
4 276 which is terminated in a plug 280 which is matingly
5 engagable with a receptacle 282 of the tissue impedance
6 measuring device 284. The R.F. source 285 is in
7 electrical communication with the impedance measuring
8 device via electrical lines 283a and 283b. The source 285
9 and the impedance measuring device 284 are connectable in
10 parallel in order to get realtime impedance measurement of
11 tissue engaged between the first ends 249a, 249b of each
12 of the electrode 250a, 250b.

13 The movement mechanism 236 includes a finger ring
14 portion 252, and a thumb ring portion 254. The finger
15 ring portion 252 is a generally flat plate having finger
16 loops 251a, 251b formed therein. A passage 262 is formed
17 through the finger ring portion 252 such that the
18 longitudinal axis of the passage 262 is disposed between
19 each finger loop and lies coplanar with the plane of each
20 finger loop. The sleeve 256, and a cylinder 258 are
21 partially inserted into opposite ends of the passage 262.
22 The sleeve 256 has a passage longitudinally formed therein
23 so as to receive the covering 244. The cylinder 258 has
24 a passage longitudinally formed therein which is aligned
25 with the passage of the sleeve. The plunger 264 is
26 slideable within the passage of the cylinder 258. One end
27 of the plunger is attached to the thumb ring portion 254,
28 and the connection pins 272a, 272b are mounted to the
29 other end of the plunger 264. The outer surface of the
30 plunger 264 is visible through an access cutout 270 formed
31 in the cylinder 258. In one embodiment, an indicator post
32 266 is attached to the outer surface of the plunger 264
33 and passes through the access cutout 270 to give an
34 immediate visual indication of the position of the plunger
35 264 within the cylinder 258. In a preferred embodiment,
36 the outer surface of the plunger 264 is scored with a
37 plurality of indicator marks 268 to provide a visual
38 indication of the position of the plunger 264 within the

1 cylinder 258, which corresponds to variable length of
2 extension of each of the electrodes beyond their
3 respective insulating sheaths.

4 In operation, the irrigation and evacuation valves, and
5 the endoscope operate as described above. Regarding the
6 retractable electrode assembly 202, a free hand of the
7 surgeon is used to operate the movement mechanism 236.
8 The surgeon's fingers are engaged within the finger ring
9 loops and the thumb is engaged within the thumb ring
10 portion. The thumb either pushes or pulls on the thumb
11 ring thereby moving the attached plunger 264 into or out
12 of the cylinder 258 and the passage 262. As the plunger
13 264 moves each of the first ends 249a, 249b of each of the
14 electrodes 250a, 250b move because the connection pins
15 272a, 272b mounted to the plunger are attached to each of
16 the second ends 247a, 247b of each of the electrodes 250a,
17 250b. Thus, as the plunger moves in the direction of the
18 arrow A, the central portions of each of the electrodes
19 moves within their respective insulators in the direction
20 of the arrow B, and the first ends 249a, 249b move in the
21 direction of the arrow C.

22 FIG. 21 illustrates the first end 249 of the electrode
23 250. The guide sheath 248 is formed with a bend at one
24 end. The electrode 250 slides within the sheath 248 and
25 exits the sheath 248 under the guidance of the sheath 248.
26 The insulating cover 246 permits the easy sliding of the
27 electrode within the sheath 248. Although a bend of 90
28 degrees is illustrated, it will be appreciated that a bend
29 of any angle may be formed in the sheath 248 so as to
30 guide the electrode 250 into a variety of angular
31 dispositions. It should be noted that the electrode 250
32 is bare in the vicinity of the first end 249. A
33 predetermined length value L, measured from the tip of the
34 electrode to the end 255 of the insulating coat 246,
35 represents the length of the electrode 250 that is bare or
36 uncoated. Typical values for L range from 0 to 3 cm.

37 The first ends of each electrode extends beyond its
38 respective sheath 248 by a length greater than the

1 predetermined extension length L in order to permit the
2 bare electrode to penetrate a tissue portion up to the
3 full L value. Further, the first ends of each needle
4 electrode are separated by a predetermined separation
5 width W (typically 0.1-2.0 cm) and each first end forms a
6 predetermined angle θ with respect to the longitudinal
7 axis of portion 228. In the illustrated embodiment, the
8 angle θ is 90 degrees. Typical values for θ range between
9 0 and 360 degrees.

10 During surgical procedures, the tip end 230 of the
11 portion 228 of the instrument 200 is brought adjacent to
12 a target tissue area of the body cavity. The first ends
13 of each electrode are extended beyond their respective
14 sheaths such that each first end is embedded into the soft
15 target tissue area thereby defining a tissue portion
16 engaged between the adjacent first ends of each electrode.
17 The power source is energized and R.F. energy is
18 transmitted from one electrode to the adjacent electrode.
19 The energy transmission causes a coagulation of the tissue
20 portion engaged between the adjacent electrodes and
21 ablation of the target tissue.

22 Using the present invention, the surgeon can predict and
23 control the amount of tissue ablation/coagulation with
24 greater accuracy and safety. As described above, the
25 spacing between the two parallel first ends of each
26 electrode remains constant at some predetermined W value,
27 e.g. 1.0 cm. Also, the extension of the electrodes beyond
28 the insulators at a given angle, i.e. the depth of
29 penetration of each first ends of each electrode into the
30 soft tissue portion, can be precisely controlled by
31 observing the indicator marks on the plunger.
32 Predictable and precise tissue ablation is therefore
33 possible with the present invention because the depth of
34 each first end of each electrode in soft tissue can be
35 precisely controlled by the surgeon. That is, the surgeon
36 can predict a cylindrical zone of ablation by controlling
37 the depth of the retractable first ends into the soft
38 tissue portion. This precise depth control enables the

1 surgeon to predict the zone of ablation with greater
2 accuracy and safety than prior art non-retractable
3 monopolar RF devices, or prior art laser delivery systems.

4 The cellular structure of body tissue contains water
5 which is a conductor of electrical energy. Consequently,
6 a portion of body tissue also has an associated resistance
7 or impedance value. In prior art monopolar electrode
8 devices, tissue impedance is difficult to measure.
9 However, in the present invention, precise impedance
10 measurement of the soft tissue in the proximity of the
11 bipolar electrodes is possible. In the present invention,
12 during the tissue coagulation process simultaneous
13 measurement of the impedance of the tissue engaged between
14 the extended first ends of the electrodes signals the
15 completion of the tissue coagulation process and provides
16 assurance and confirmation to the surgeon.

17 R.F. energy applied to the tissue engaged between the
18 first ends of the two electrodes causes the tissue to
19 coagulate which decreases the water content associated
20 with the tissue. As the water content decreases the
21 conductivity of the tissue decreases. For a constant R.F.
22 energy, as the conductivity decreases the impedance (or
23 resistance) associated with the tissue increases. The
24 tissue impedance is highest when the tissue is completely
25 coagulated, since coagulated tissue has a minimum amount
26 of water content and current flow is blocked from one
27 electrode to the other electrode. However, at the
28 beginning of the ablation procedure, the tissue impedance
29 is at a minimum because the water content of the tissue is
30 at its highest level and the tissue is a good conductor
31 and allows the maximum current to flow from one electrode
32 to the other. During the ablation procedure, as the
33 tissue coagulates the water content decreases and the
34 tissue impedance increases. The tissue impedance
35 measurement device 284 can be designed to transmit an
36 variable frequency audible signal, i.e. a beeping tone,
37 when the tissue impedance is at its lowest value. As more
38 tissue is ablated and as the tissue impedance reaches its

highest value the audible signal decreases in frequency. In the present invention, the tissue impedance is monitored or measured on a relative basis. That is, the impedance measured or monitored is the impedance of the tissue engaged between the two needle electrodes.

FIG. 22A through 22H illustrate alternate electrode configurations. It will be noted that the preferred embodiment of the present invention includes two electrodes with a θ of 90 degrees, and a L value of 0-3 cm, and a W value of 0.1-2.0 cm. It will be appreciated that a variety of electrode configurations, with associated L, W, and θ values within the above specified ranges, are possible. However, it is generally preferable to limit the total number of electrodes to six or less.

15 It will be noted that in the embodiments illustrated in
16 FIG. 22A-22C, 22G-22H, the electrodes 250 are guided by
17 the shape of the sheath 248. That is, the electrodes can
18 be directed towards or away from each other if the guide
19 sheaths are angled towards or away from each other.
20 Similarly, different θ values are possible if the sheaths
21 are formed with the appropriately angled bands.

22 However, in the embodiments illustrated in FIG. 22D-22F,
23 the sheaths are substantially straight and the electrodes
24 themselves are bent in order to direct them in certain
25 orientations. This feature is more clearly shown in FIG.
26 23 which illustrates a typical electrode having a bend
27 formed at the location depicted by numeral 257. When the
28 electrode is disposed within the sheath 248, the electrode
29 250 is in contact with at least one portion 259 of the
30 inner surface of the sheath 248 because of the bend 257.
31 When the electrode is extended beyond the sheath (shown in
32 phantom lines), the electrode "flattens" within the sheath
33 248 while the electrode tip angles away from the sheath
34 centerline in accordance with the bend 257 formed in the
35 electrode.

36 FIG. 24 illustrates a retractable electrode surgical
37 instrument 300 which is an alternate embodiment of the
38 retractable electrode instrument 200 (FIG. 17). The

1 instrument 300 includes many of the same elements as the
2 instrument 200. These identical elements are identified
3 with the same reference numeral as shown in FIG. 17. In
4 this embodiment, each electrode 250a, 250b is enclosed
5 within a bendable guiding sheath 290a, 290b. A guide wire
6 293a, 293b is disposed within each sheath 290a, 290b and
7 includes a first end 289a, 289b and a second end 291a,
8 291b. Each first end 289 of each guide wire 293 is
9 attached (e.g. welded or adhesively bonded) to an inner
10 surface of a bendable or bellows portion 292 of the sheath
11 290 at a location proximate the open end of the sheath
12 290. Each second end 291 is attached to a lever or knob
13 294 which is mounted to an outer surface of a housing 291.
14 The housing 291 is similar to the housing 232 and includes
15 communication ports for an irrigation valve and an
16 evacuation valve (neither shown). In operation, when
17 there is no tension on the guide wires the sheaths are
18 straight within the conduit, i.e. θ is 0 degrees. As the
19 surgeon pulls back on the knob or lever, the wires are
20 tensioned and the tips of each sheath is pulled back as
21 illustrated until a desired θ value is obtained. In this
22 embodiment, both the L and the θ values can be adjusted by
23 the surgeon in situ.

24 Although the present invention has been described above
25 in terms of a specific embodiment, it is anticipated that
26 alterations and modifications thereof will no doubt become
27 apparent to those skilled in the art. It is therefore
28 intended that the following claims be interpreted as
29 covering all such alterations and modifications as fall
30 within the true spirit and scope of the invention.

What is claimed is:

CLAIMS

1. An endoscopic surgical instrument comprising:
 - 2 a) a housing;
 - 3 b) a single access conduit being disposed within said housing, and having a proximal end and a distal end;
 - 4 c) an irrigation port formed in said housing;
 - 5 d) an evacuation port formed in said housing, each of said irrigation and said evacuation ports being in fluid communication, through independent valves, with said proximal end of said single access conduit;
 - 6 e) an aperture and a closure therefor, said aperture being formed in said housing, and said closure being openable to allow the ingress of microsurgical instrumentation into said proximal end of said single access conduit; and
 - 7 f) RF electrode means insertable into said aperture and into said single access conduit and having a length so as to protrude beyond said distal end of said single access conduit, said RF electrode means for engaging a body tissue portion, and for simultaneously ablating said body tissue portion and measuring an impedance value associated with said body tissue portion.
1. An endoscopic surgical instrument as recited in claim 1, wherein said RF electrode means includes:
 - 2 a) a first RF electrode having a distal end and a proximal end, said first RF electrode being disposed within an insulating sheath;
 - 3 b) elongated guide means encasing said first RF electrode and said insulating sheath, for guiding said first RF electrode to a predetermined angle value from the longitudinal axis of said single access conduit;
 - 4 c) electrode movement mechanism means, attached to said proximal end of said first RF electrode, for moving said first RF electrode within said guide means, said distal end of said first RF electrode is extendable beyond an open end of said guide means up to a predetermined

15 length value and engagable with and insertable into said
16 body tissue portion;

17 d) energy source means, in electrical communication
18 with said proximal end of said first RF electrode, for
19 transmitting energy into said distal end of said first RF
20 electrode when it is extended beyond said guide means and
21 into said body tissue portion to ablate said body tissue
22 portion; and

23 e) tissue impedance measurement means, in electrical
24 communication with said proximal end of said first RF
25 electrode, for measuring an impedance associated with said
26 body tissue portion engaged with said distal end of said
27 first RF electrode when it is extended beyond said guide
28 means.

1 3. An endoscopic surgical instrument as recited in
2 claim 2 which further includes:

3 a) at least one other second RF electrode having a
4 distal end and a proximal end, said second RF electrode
5 being disposed within a second insulating sheath;

6 b) elongated second guide means encasing said second
7 RF electrode and said second insulating sheath, for
8 guiding said second RF electrode into a second
9 predetermined angle value from the longitudinal axis of
10 said single access conduit said second RF electrode
11 separated from said first RF electrode by a predetermined
12 width value;

13 c) said proximal end of said second RF electrode is
14 attached to said electrode movement mechanism means, and
15 said distal end of said second RF electrode is extendable
16 beyond an open end of said second guide means up to a
17 second predetermined length value so as to be engagable
18 with and insertable into said body tissue portion;

19 d) said distal end of said second RF electrode is in
20 electrical communication with said energy source means and
21 said tissue impedance measurement means; and

22 e) whereby said electrode movement mechanism means
23 moves each of said first RF and said second RF electrodes

24 within each of associated guide means, and said distal
25 ends of each of said first RF electrode and said second RF
26 electrode is extendable beyond and retractable within each
27 of said associated guide means, and when each of said
28 distal ends of each RF electrode is extended beyond said
29 associated guide means said energy source means is
30 energized to pass electrical current from one RF electrode
31 to the other and said tissue impedance measurement means
32 measures the impedance of tissue engaged between each of
33 said distal ends of each RF electrode.

1 4. An endoscopic surgical instrument as recited in
2 claim 3, wherein:

- 3 a) said predetermined angle value is greater than 0
4 degrees and is less than 360 degrees;
- 5 b) said second predetermined angle value is greater
6 than 0 degrees and is less than 360 degrees;
- 7 c) said predetermined length value is greater than 0
8 cm and is less than 3 cm;
- 9 d) said second predetermined length value is greater
10 than 0 cm and is less than 3 cm; and
- 11 e) said predetermined width value is greater than 0.1
12 cm and is less than 2.0 cm.

1 5. An endoscopic surgical instrument as recited in
2 claim 3, wherein:

- 3 a) said predetermined angle value is equal to said
4 second predetermined angle value; and
- 5 b) said predetermined length value is equal to said
6 second predetermined depth value.

1 6. A retractable RF electrode assembly for ablating
2 and measuring the impedance of a body tissue portion,
3 comprising:

- 4 a) a first RF electrode having a distal end and a
5 proximal end, said first RF electrode being disposed
6 within an insulating sheath;

7 b) elongated guide means encasing said first RF
8 electrode and said insulating sheath, for guiding said
9 first RF electrode into a predetermined angle value from
10 the longitudinal axis of said single access conduit;
11 c) electrode movement mechanism means, attached to
12 said proximal end of said first RF electrode, for moving
13 said first RF electrode within said guide means, said
14 distal end of said first RF electrode is extendable beyond
15 an open end of said guide means up to a predetermined
16 length value and engagable with and insertable into said
17 body tissue portion;
18 d) energy source means, in electrical communication
19 with said proximal end of said first RF electrode, for
20 transmitting energy into said distal end of said first RF
21 electrode when it is extended beyond said guide means and
22 into said body tissue portion so as to ablate said body
23 tissue portion; and
24 e) tissue impedance measurement means, in electrical
25 communication with said proximal end of said first RF
26 electrode, for measuring an impedance associated with said
27 body tissue portion engaged with said distal end of said
28 first RF electrode when it is extended beyond said guide
29 means.

1 7. A retractable RF electrode assembly as recited in
2 claim 6 which further includes:
3 a) at least one other second RF electrode having a
4 distal end and a proximal end, said second RF electrode
5 being disposed within a second insulating sheath;
6 b) elongated second guide means encasing said second
7 RF electrode and said second insulating sheath, for
8 guiding said second RF electrode into a second
9 predetermined angle value from the longitudinal axis of
10 said single access conduit, said second RF electrode
11 separated from said first RF electrode by a predetermined
12 width value;
13 c) said proximal end of said second RF electrode is
14 attached to said electrode movement mechanism means, and

15 said distal end of said second RF electrode is extendable
16 beyond an open end of said second guide means up to a
17 second predetermined length value so as to be engagable
18 with and insertable into said body tissue portion;

19 d) said proximal end of said second RF electrode is in
20 electrical communication with said energy source means and
21 said tissue impedance measurement means; and

22 e) whereby said electrode movement mechanism means
23 moves each of said first RF and said second RF electrodes
24 within each of associated guide means, and said distal
25 ends of each of said first RF electrode and said second RF
26 electrode is extendable beyond and retractable within each
27 of said associated guide means, and when each of said
28 distal ends of each RF electrode is extended beyond said
29 associated guide means said energy source means is
30 energized to pass electrical current from one RF electrode
31 to the other and said tissue impedance measurement means
32 measures the impedance of tissue engaged between each of
33 said distal ends of each RF electrode.

1 8. A retractable RF electrode assembly as recited in
2 claim 7, wherein:

3 a) said predetermined angle value is greater than 0
4 degrees and is less than 360 degrees;

5 b) said second predetermined angle value is greater
6 than 0 degrees and is less than 360 degrees;

7 c) said predetermined length value is greater than 0
8 cm and is less than 3 cm;

9 d) said second predetermined length value is greater
10 than 0 cm and is less than 3 cm; and

11 e) said predetermined width value is greater than 0.1
12 cm and is less than 2.0 cm.

1 9. A retractable RF electrode assembly as recited in
2 claim 8, wherein:

3 a) said predetermined angle value is equal to said
4 second predetermined angle value; and

5 b) said predetermined length value is equal to said
6 second predetermined depth value.

1 10. An endoscopic surgical instrument as recited in
2 claim 2, further including:

3 a) means for bending said guide means to vary said
4 predetermined angle value.

1 11. An endoscopic surgical instrument as recited in
2 claim 10, wherein

3 a) said guide means includes a bendable bellows
4 portion disposed at a distal end of said guide means;

5 b) said bending means includes

6 i) a lever attached to said housing;

7 ii) a guide wire disposed within said guide means
8 and having a first end attached to said bellows portion of
9 said guide means; and

10 11. An endoscopic surgical instrument as recited in
11 claim 10, wherein
12 c) whereby actuating said lever tensions said guide
13 wire and varies said predetermined angle value.

1 12. An endoscopic surgical instrument as recited in
2 claim 3, further including:

3 a) means for bending each of said guide means for each
4 of said first RF electrode and said second RF electrode to
5 vary each of said predetermined and said second
6 predetermined angle values.

1 13. An endoscopic surgical instrument as recited in
2 claim 10, wherein

3 a) each of said guide means for each said first and
4 said second RF electrodes includes a bendable bellows
5 portion disposed at a distal end of each of said guide
6 means;

7 b) each of said bending means for each of said guide
8 means includes

9 i) a lever attached to said housing;

13 c) whereby actuating said lever tensions each of said
14 guide wires and varies each of said predetermined and said
15 second predetermined angle value.

1 14. A retractable RF electrode assembly as recited in
2 claim 6, further including:

3 a) means for bending said guide means to vary said
4 predetermined angle value.

1 15. A retractable RF electrode assembly as recited in
2 claim 14, wherein

3 a) said guide means includes a bandable bellows
4 portion disposed at a distal end of said guide means;

5 b) said banding means includes

6 i) a lever attached to said housing;

10 c) wheraby actuating said lever tensions said guide
11 wire and varies said predetermined angle value.

1 16. A retractable RF electrode assembly as recited in
2 claim 7, further including:

3 a) means for bending each of said guide means for each
4 of said first RF electrode and said second RF electrode to
5 vary each of said predetermined and said second
6 predetermined angle values.

1 17. A retractable RF electrode assembly as recited in
2 claim 16, wherein

3 a) each of said guide means for each said first and
4 said second RF electrodes includes a bendable bellows
5 portion disposed at a distal end of each of said guide
6 means;

7 b) each of said bending means for each of said guide
8 means includes
9 i) a lever attached to said housing;
10 ii) a guide wire disposed within each of said
11 guide means and having a first end attached to each said
12 bellows portion of each of said guide means; and
13 c) whereby actuating said lever tensions each of said
14 guide wires and varies each of said predetermined and said
15 second predetermined angle value.

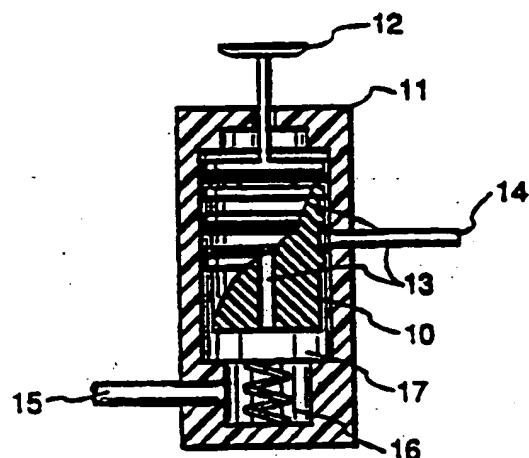


Fig. 1

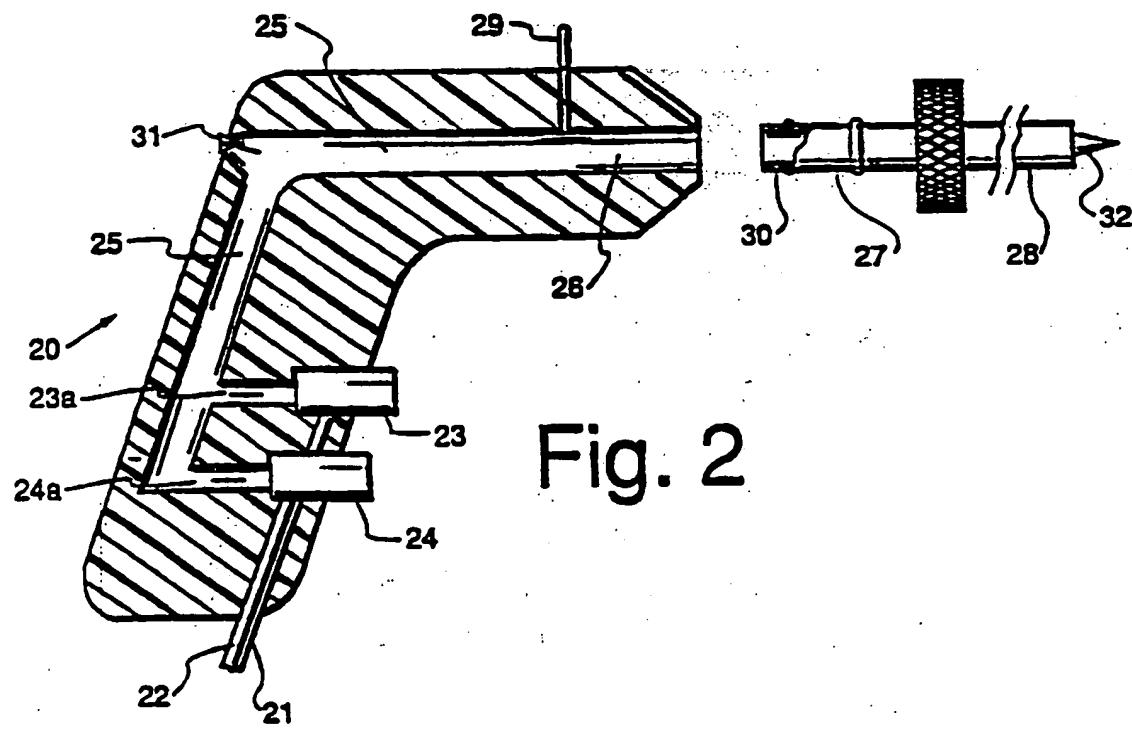


Fig. 2

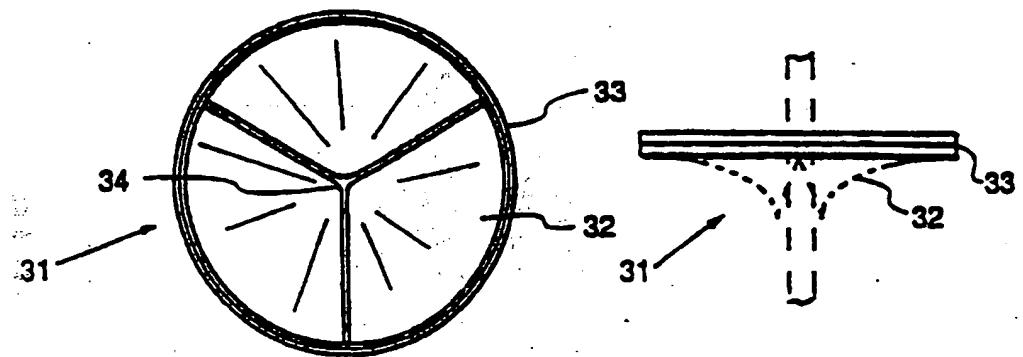


Fig. 3a

Fig. 3b

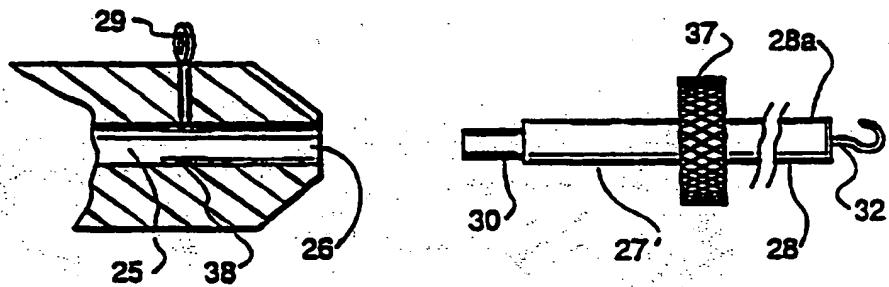


Fig. 4a

Fig. 4b

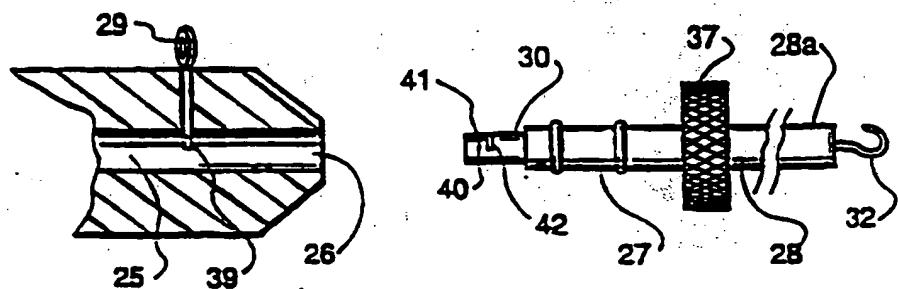


Fig. 5a

Fig. 5b

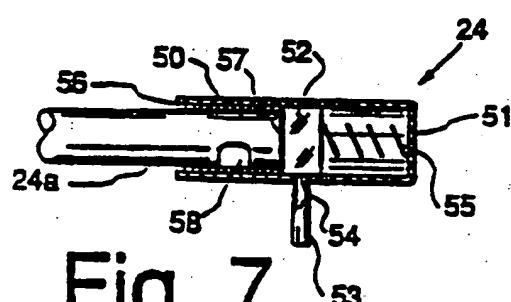


Fig. 7

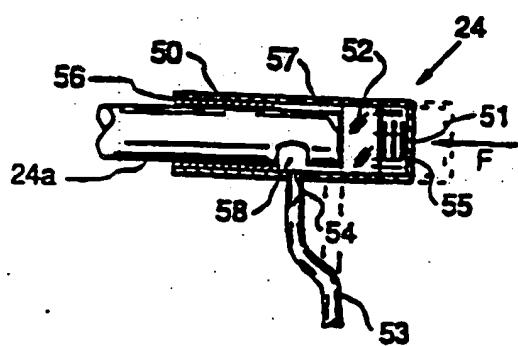


Fig. 8

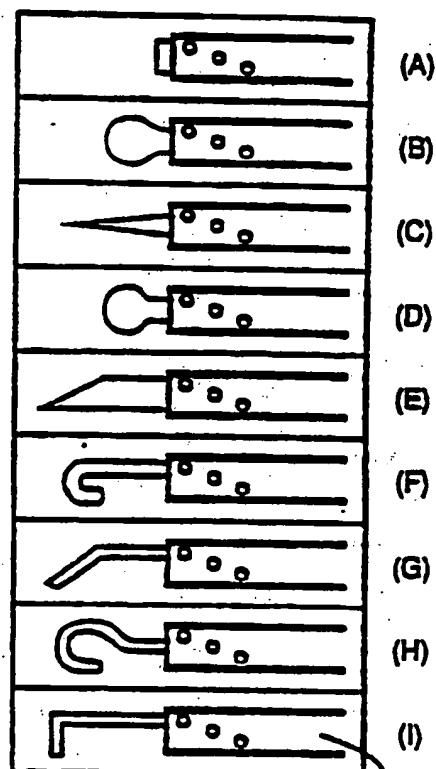


Fig. 6

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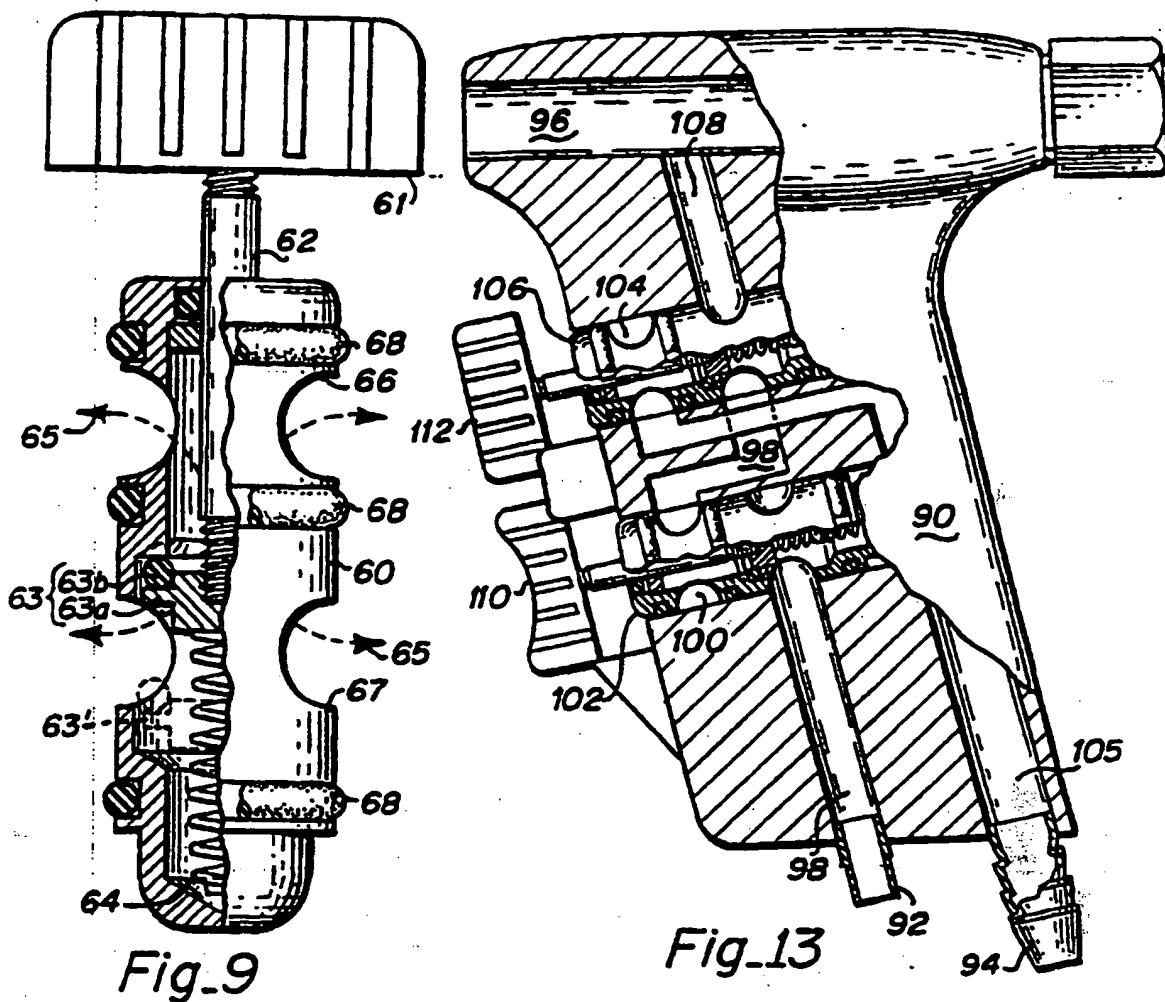


Fig. 9

Fig. 13

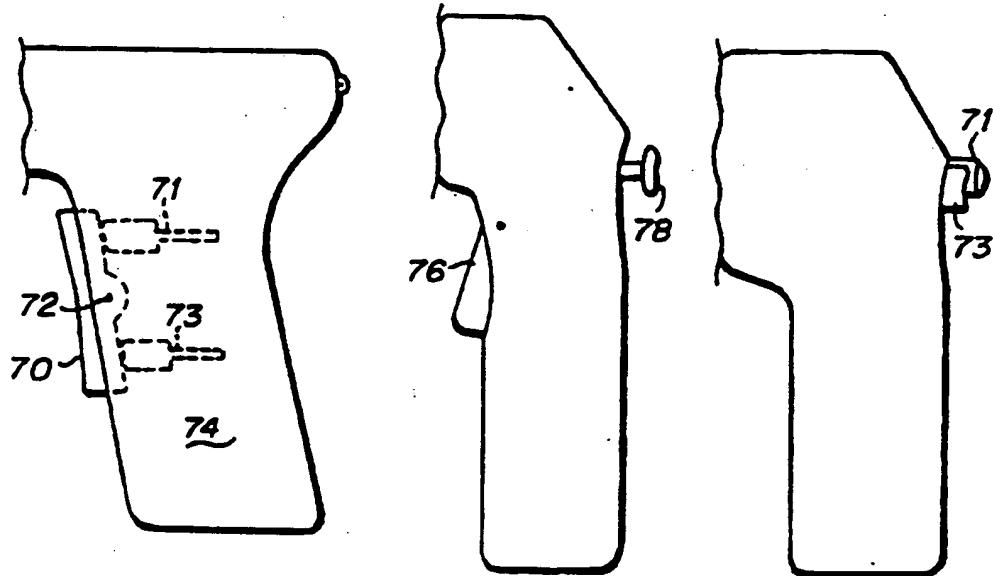


Fig. 10

Fig. 11

Fig. 12

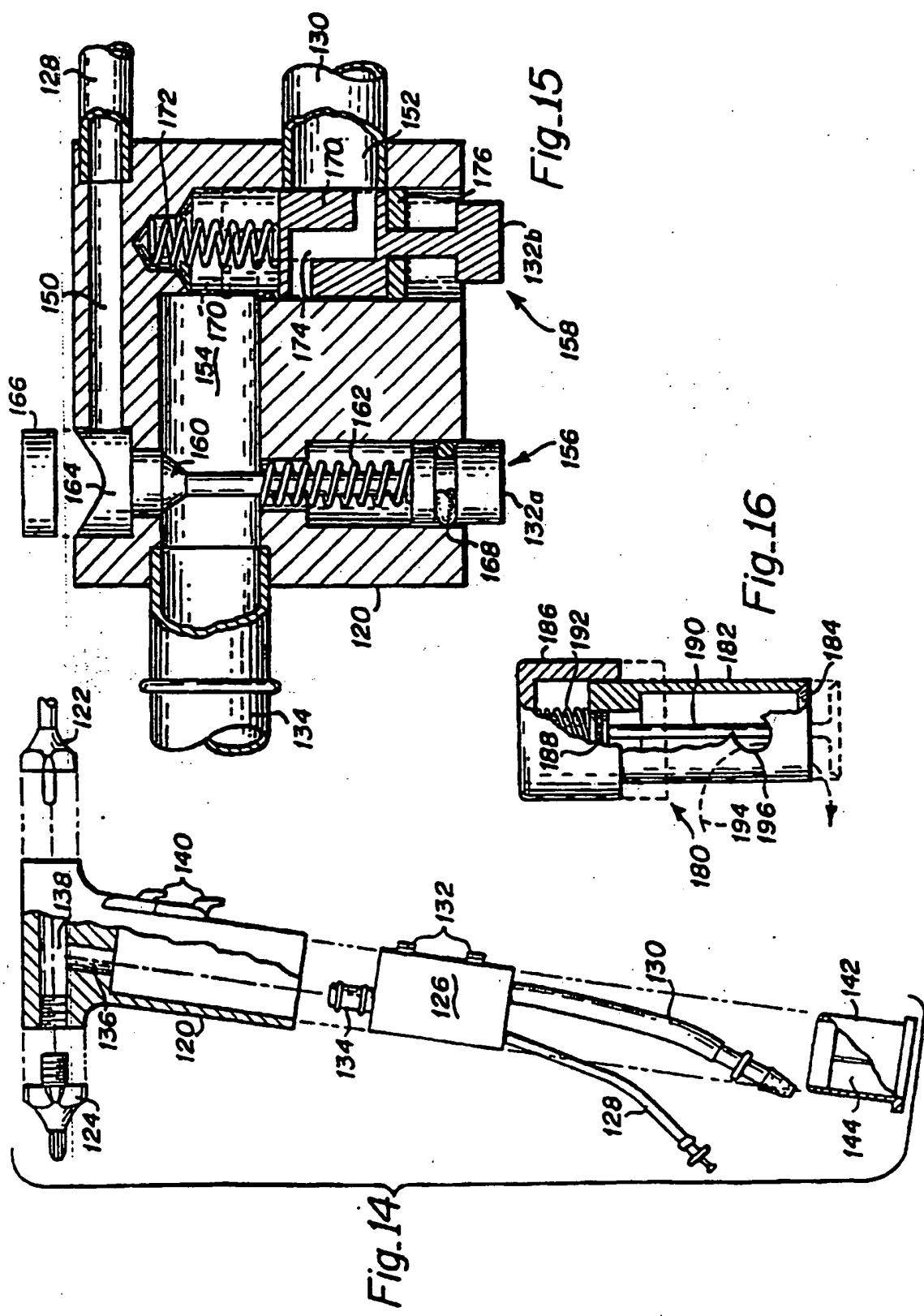
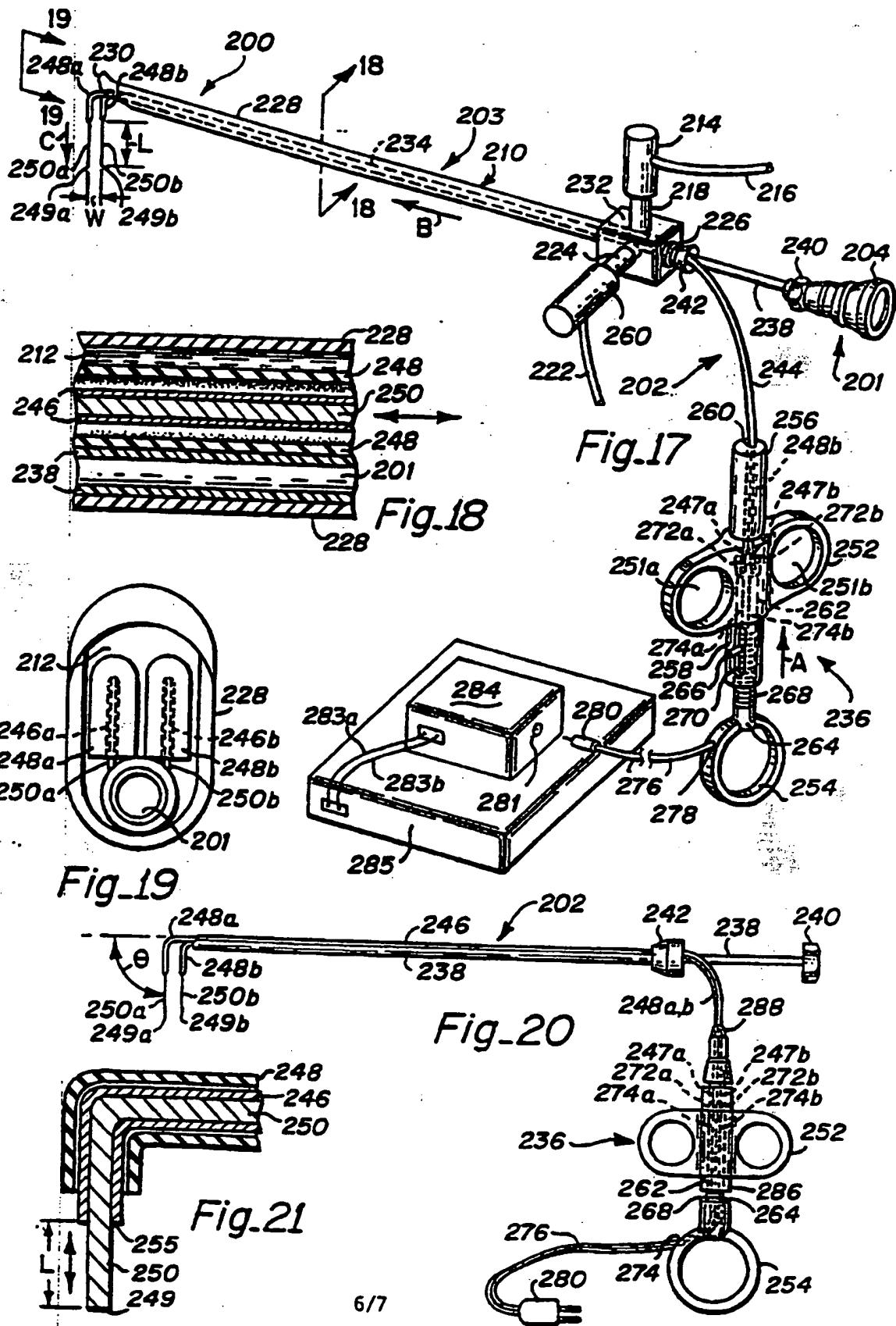


Fig. 14

Fig. 15

Fig. 16



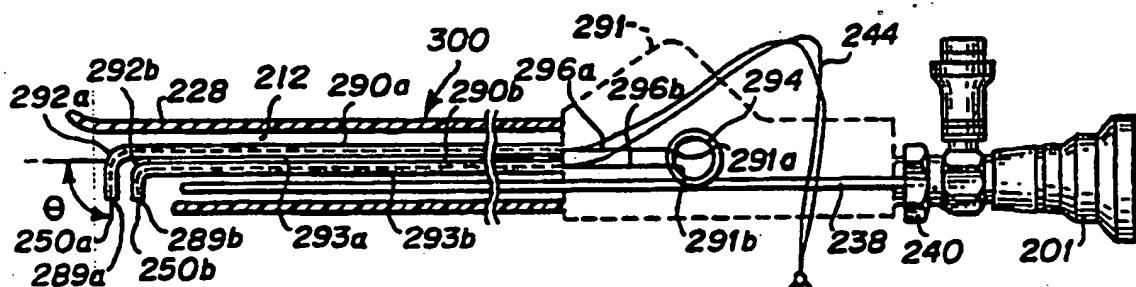
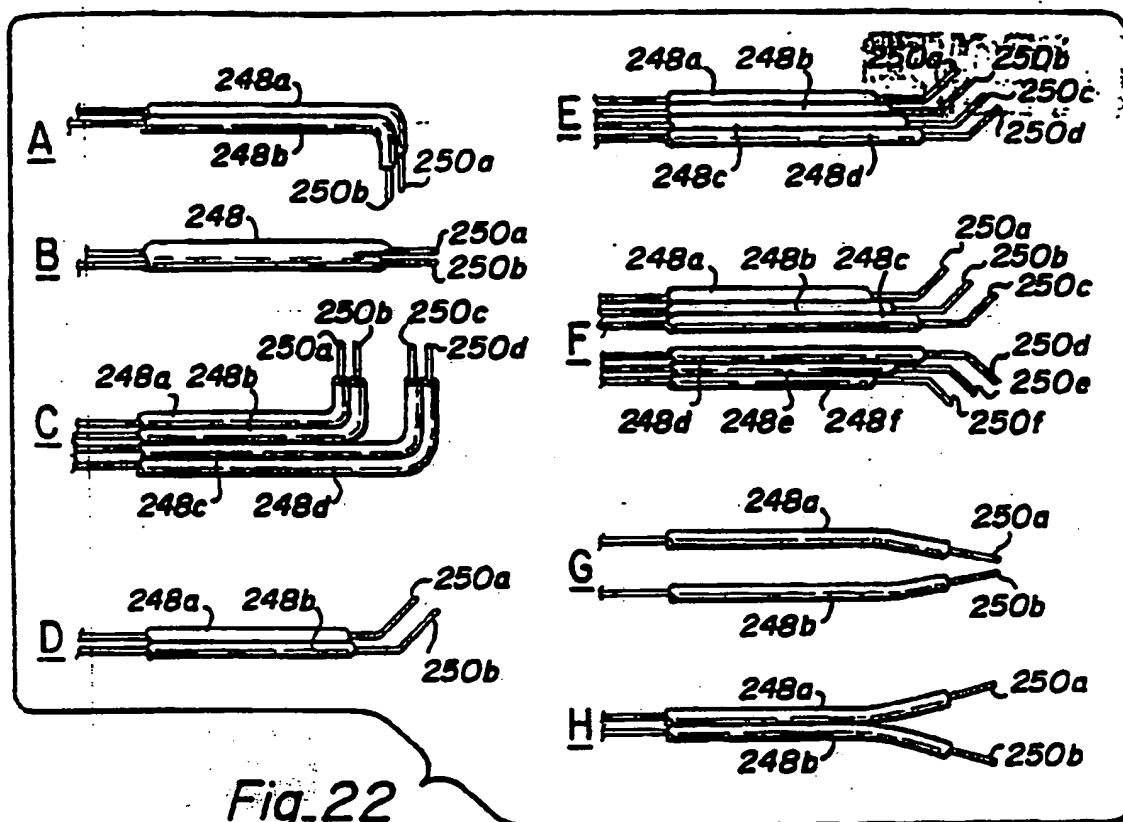


Fig. 24

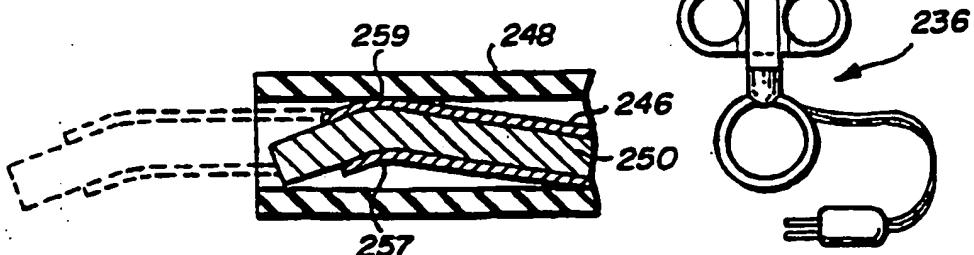


Fig. 23

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US95/09152

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) A61P 5/48
US CL : 128/385; 600/29; DIG.25

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 128/346, 385; 600/29; DIG. 25

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONEElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,195,958 (PHILLIPS) 23 March 1993, see the entire document.	1
Y	US, A, 4,565,200 (COSMAN) 21 January 1986, see the entire document.	1
A	US, A, 5,186,714 (BOUDEREAULT ET AL.) 16 February 1993, see the entire document.	2-17
A	US, A, 4,402,310 (KIJMURA) 06 September 1983, see the entire document.	2-17

Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search

10 OCTOBER 1995

Date of mailing of the international search report

26 OCT 1995

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